

WHAT IS CLAIMED IS:

1 1. A radio receiver, comprising:
2 an amplifier configured to receive and amplify an intermediate frequency
3 modulated signal having in-phase and quadrature phase DC components;
4 an analog-to-digital converter configured to receive the amplified intermediate
5 frequency modulated signal and convert it to a digital signal;
6 a demodulator operable to demodulate the digital signal; and
7 DC offset calibration means coupled to the demodulator operable to provide
8 in-phase and quadrature phase DC offset correction signals to compensate for the in-phase
9 and quadrature phase DC components at the input of the amplifier.

1 2. The radio receiver of claim 1, further comprising:
2 delay measurement means coupled to the demodulator operable to determine a
3 delay vector characterizing the in-phase and quadrature phase DC components.

1 3. The radio receiver of claim 2, wherein the delay vector is used by the
2 DC offset calibration means to provide a digital representation of the in-phase and quadrature
3 phase DC offset correction signals.

1 4. The radio receiver of claim 3, further comprising:
2 a first digital-to-analog converter configured to receive a in-phase component
3 of the digital representation of the in-phase DC offset correction signal for mixing with an in-
4 phase signal and an intermediate frequency carrier signal;
5 a second digital-to-analog converter configured to receive a quadrature phase
6 component of the digital representation of the quadrature phase DC offset correction signal
7 for mixing with a quadrature signal and the intermediate frequency carrier signal; and
8 a summer operable to subtract the mixed quadrature phase signal and
9 quadrature phase DC offset correction signal component from the mixed in-phase signal and
10 in-phase DC offset correction signal to provide a DC compensated intermediate frequency
11 modulated signal at the input of the low noise amplifier.

1 5. A radio receiver, comprising:
2 a receiving stage configured to receive a radio signal;
3 a first mixer stage operable to downconvert the radio frequency signal to a
4 first intermediate frequency in-phase signal and a first intermediate quadrature phase signal;

5 first and second low pass filters configured to receive and low pass filter the
6 first intermediate frequency in-phase and quadrature phase signals;
7 a second mixer stage operable to upconvert the filtered first intermediate
8 frequency in-phase and quadrature phase signals and provide a second intermediate
9 frequency in-phase signal and a second intermediate frequency quadrature phase signal;
10 a summer operable to subtract the second intermediate frequency quadrature
11 phase signal from the second intermediate frequency in-phase signal to provide an integrated
12 signal;
13 an automatic gain control stage coupled to the summer and operable to
14 amplify the integrated signal;
15 an analog-to-digital converter operable to convert the amplified integrated
16 signal to a digital signal;
17 a demodulator operable to demodulate the digital signal; and
18 delay measurement means for determining a delay vector from inputs of the
19 low pass filters to an output of the demodulator.

20
21 6. The radio receiver of claim 5, further comprising:
22 a DC offset calibrator coupled to the delay measurement means;
23 an in-phase digital-to-analog converter coupled between the DC offset
24 calibrator and the second mixer stage; and
25 a quadrature phase digital-to-analog converter coupled between the DC offset
26 calibrator and the second mixer stage,
27 wherein the in-phase digital-to-analog converter is operable to provide an in-
28 phase DC offset compensation signal for the automatic gain control stage and the quadrature
29 phase digital-to-analog converter is operable to provide a quadrature phase DC offset
30 compensation signal for the automatic gain control stage..

31 7. A method of determining a signal delay between inputs of first and
32 second low pass filters of a dual mixer stage radio receiver and an output of the receiver's
33 demodulator, the method comprising the steps of:
34 applying a first known voltage to an input of an in-phase mixer of the second
35 mixer stage;
36 applying a second known voltage to an input of a quadrature phase mixer of
37 the second mixer stage;

8 setting the gain of an automatic gain control stage, coupled to the second
9 mixer stage, to a full gain; measuring first in-phase and first quadrature phase components at
10 the output of the demodulator;
11 decreasing the gain of the automatic gain control stage by a predetermined
12 amount if the value of each first component is greater than a predetermined maximum
13 threshold value;
14 storing the first in-phase and quadrature phase components if the value of each
15 component is less than the predetermined maximum threshold value;
16 applying the negative of the first known voltage to the input of the in-phase
17 mixer;
18 applying the value of the second known voltage to the input of the quadrature
19 phase mixer;
20 measuring second in-phase and second quadrature phase components at the
21 output of the demodulator;
22 decreasing the gain of the automatic gain control stage by a predetermined
23 amount if the value of each second component is greater than the predetermined maximum
24 threshold value;
25 storing the second in-phase and quadrature phase components if the value of
26 each second component is less than the predetermined maximum threshold value; and
27 using the first and second quadrature phase components to compute the signal
28 delay..

1 8. A method of compensating for DC offset voltages present at an input
2 of a low noise amplifier of a dual mixer stage radio receiver, the method comprising the steps
3 of:

4 determining a signal delay between an output of a second mixer stage of the
5 dual mixer stage radio receiver, said signal delay characterizing in-phase and quadrature
6 phase components of the DC offset voltage present at the input of the low noise amplifier;
7 using the determined signal delay to separate and define digital representations
8 of the in-phase DC offset voltage component and the quadrature phase DC offset voltage
9 component;
10 making the digital representation of each of the in-phase and quadrature phase
11 components more positive or more negative if it is more negative or more positive than a
12 predetermined minimum threshold or maximum threshold; and

performing the above sequence of steps a predetermined number of times to reduce the DC offset voltage at the input of the low noise amplifier.

9. A method of setting signal levels of in-phase and quadrature phase components of a radio receiver between a minimum threshold voltage and a maximum threshold voltage, the method comprising the steps of:

(a) setting the gain of an automatic gain control to a gain value at which the signal levels of the in-phase and quadrature phase components are less than or equal to the maximum threshold voltage;

(b) comparing the signal levels of the in-phase and quadrature phase components to a predetermined minimum threshold value;

(c) increasing the gain of the automatic gain control stage by a predetermined amount; and

(d) repeating steps (b) and (c) until the signal levels of the in-phase and quadrature phase components are greater than or equal to the predetermined minimum threshold value.

10. A method of compensating for DC offset voltages at inputs of in-phase and quadrature phase low pass filters of a dual mixer stage radio receiver, said method comprising the steps of:

determining a signal delay vector between the inputs of the low pass filters, said signal delay vector characterizing in-phase and quadrature phase components of DC offset voltages at the inputs of the low pass filters;

using the signal delay vector to separate and define in-phase and quadrature phase multiplication factors associated with the in-phase and quadrature phase DC offsets;

incrementally adjusting the signal level of the in-phase component to a more positive or more negative value if the in-phase multiplication factor has a negative or positive value, respectively; and

incrementally adjusting the signal value of the quadrature phase component to a more positive or more negative value if the quadrature phase multiplication factor has a negative or positive value, respectively.